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THE ABSORPTION SPECTRUM OF AMERICIUM

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ABSTRACT

The absorption spectra of aqueous solutions and solid compounds of americium have been investigated with a Baird 3-meter grating spectrograph.

The relation of the spectrum to that of other actinide and rare-earth compounds is discussed.

INTRODUCTION

It has long been observed that the absorption spectra of the trivalent rare-earth ions possess a unique sharpness, the structure of the peaks being discernible at room temperature and even in solutions. This phenomenon has also been observed in the case of the electronically analogous actinide elements.

The generally accepted explanation for the origin of the lines in the rare-earth spectra is that they result from transitions within the 4f electron shell.

Trivalent europium, the analog of americium, has been shown by absorption spectra and magnetic susceptibility data to have a $4f^6$ electron configuration, a $^7F_0$ ground state, and one or more low-lying excited levels. Since americium ion probably has a $5f^6$ configuration, it also is expected to have a singlet ground state and one or more low-lying excited levels. The following represents the first phases of the study of the absorption spectrum of americium.

EXPERIMENTAL

Apparatus

A Baird Eagle Mount Spectrograph, having 5.6 A/mm dispersion in the first order, was used for both the solution and crystal work. For the solutions a 1-cm path-length cell 2 mm wide was mounted on the arm of a micromanipulator. The cell was then placed as close to the slit as possible. The cell was of fused silica. For the wavelength below 3500 A a water-cooled hydrogen discharge lamp was used, and above 3500 A a tungsten filament lamp was used.

Since the amount of americium available is not sufficient to permit the growing of large crystals, a projection system had to be used. Light from a tungsten lamp was focused on the crystal, and an image of the crystal was focused on the slit of the spectrograph. The crystals were mounted in a cell made of 1/8-in. thick brass which had thin glass windows attached.

Solution Absorption Spectrum

The absorption spectrum of trivalent americium in perchloric acid solution has been measured in the wavelength range 2200 to 10,000 A, and the results appear in Table 1. The spectrograms show a marked similarity to those of rare-earth solutions, but the americium absorption is much more intense. The absorption in the 5000 A region is especially strong, and it was found to persist at very low concentrations.

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The measurements were made using a solution 0.04M in americium and 0.5M in perchloric acid. However, to detect the four components of the 5000 A peak, it was necessary to reduce the americium concentration to about 10 per cent of the above. With this solution none of the other lines were discernible.

Solid Absorption Spectrum

The absorption spectrum of samples of hydrated americium chloride containing approximately 100 μg of americium has been measured in the region 3500 to 5500 A at room temperature (Table 2). Work is now in progress to extend this range and to obtain similar data at low temperatures.

The samples were prepared by slow evaporation of americium chloride solutions which had been carefully purified and which were approximately neutral.

The peak at 5000 A was resolved into ten components, compared with the four found with the solution. To measure these ten accurately, it was necessary to photograph samples of several different thicknesses.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

Table 1—Am^{+3} in $HClO_4$ at Room Temperature

λ, A	$\bar{\nu}$, cm^{-1}
8133	12,292
5166	19,353
5104	19,588
5078	19,686
5030	19,875
4543	22,003
4287	23,318
4198	23,815
4018	24,882
3784	26,420
3771	26,510
3756	26,617
3605	27,732
3391	29,477
3353	29,817
3312	30,189
2893	34,553
2861	34,940
2847	35,118
2826	35,380
2754	36,299
2705	36,952
2699	37,037
2651	37,715
2597	38,490
2537	39,406
2436	41,038
2433	41,096

Table 2—Hydrated $AmCl_3$ at Room Temperature

λ, A	$\bar{\nu}$, cm^{-1}
5168	19,346
5163	19,364
5154	19,397
5139	19,454
5104	19,587
5084	19,664
5060	19,756
5047	19,808
4991	20,030
4974	20,098
4695	21,293
4646	21,517
4639	21,550
4596	21,752
4555	21,948
4429	22,572
4320	23,138
4314	23,170
3940	25,374
3800	26,307
3786	26,406
3761	26,578
3660	27,310
3621	27,602

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